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ABSTRACT

Fifteen elementary schools (310 fourth-grade pupils) used in this study were classified as serving high, middle, or low social-economic groups on the basis of information from the city offices and the administration of the metropolitan school district participating in the study. The children in all of the schools used the same text and had the same amount of instruction per week. Teachers with little experience and those with many years of experience were distributed among the schools. Based on concepts selected from the district's basic text, fifteen questions were selected for the test. In addition to answering the questions, the students were asked to suggest a way to find out the answer to each question whether or not they knew the answer. (Significant differences at the .01 level were found between the means of all three groups on the I.Q. test and raw test scores on the test of scientific understanding.) Significant differences were also found between social-economic groups when raw test score means were adjusted for I.Q. differences. (BR)

Differences In Science Concepts Held By Children From Three Social-Economic Levels

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Introduction

Science education has now become more than an incidental part of the elementary school curriculum. Many new textbooks and curricular materials have been developed or are in planning stages. Only a few of these new programs, however, are concerned specifically with materials for the educationally disadvantaged. Children are disadvantaged because of low family income, by being a member of a minority group or race, by living in a ghetto or inner city, or by moving with migrant working parents. Any of these disadvantaged or combination of them may result in educational problems.

Although programs such as "Head Start" have been implemented because there is evidence that social-economic conditions influence a child's readiness for learning and success in school, once the child is in the formal school situation, any differences resulting from social-economic influences are largely ignored, and the same curriculum often is used for all of the children in the city.

Related Studies

The literature reviewed for this study was limited to research reported in the last twenty-five years, because the nature of science teaching and the sources of information children have available are much different than the nature study oriented science before 1945. Much of the literature

examined included little or no statistical treatment of the data. This was due in part to the nature of the studies, and in some cases, to the simple failure to report important data. Studies that were characterized by clear design and that were concerned with assessing the science concepts of children, or the sources of information children use in science, were included in the literature study.

In studies where social-economic grouping was considered, Almy[1] found that children in the lower social-economic classes follow the developmental steps postulated by Piaget more slowly than children from upper or middle social-economic groups. Dart and Pradhan[2] found considerable differences in children's concepts of science and the nature of knowledge when they compared the children in Hawaii with three sub-cultural groups in Nepal. This study was still in the pilot stage and no statistical data were reported.

Investigations by Anderson,[3] McCollum,[4] Brown,[5] Haupt,[6] and Inbody[7] provided information about science concept development in children.

The sources of information children use in science were investigated by Schenke,[8] Young,[9] Bergen,[10] and Kuse.[11] The methods used to determine the sources of information that children used varied, as did the results. In some cases almost half of the science information possessed by children was attributed to observation and experimentation. In other studies, books and parents or teachers were most frequent sources of information.

The thirty-six studies reviewed included a variety of methods used in determining children's science concept development and sources of information. Only four studies were concerned with possible involvement of social-economic factors although many studies suggested that some research in this area was needed.

The Problem

The purpose of this study was to determine if children from three social-economic groups differed in their understanding of selected science concepts and in the methods they would suggest to find answers to questions associated with the concepts.

Selection of Schools

The fifteen St. Paul, Minnesota elementary schools selected for the study were classified as serving high, middle, or low social-economic groups on the basis of information obtained from the city offices and the administration of the metropolitan school district participating in the study. Only schools that served a single social-economic group and that included no racial minority groups were included. The data considered in dividing the schools into the three groups included property values, per cent of deteriorated houses, average room value, education of parents, occupations of parents, statistics from the Bureau of Health, and ratings supplied by St. Paul principals and teachers. The children in all of the schools used the same text and had the same amount of science instruction per week. Teachers with little experience and those with many years of experience were distributed among the schools in the study. No one group had all new or experienced teachers.

The Test

Science questions based on concepts selected from the system's basic text were tested in a suburban school district (comprised of children from middle and lower social-economic groups) to determine their clarity and discriminating power. In addition to answering the fifteen questions finally selected for the test, the students were asked to suggest a way to find out the answer to each question whether or not they knew the answer. The following is an example of the questions in the test:

12. Which of these three animals is the grown up? 1, 2 or 3?

    Why did you choose this one?

    If you did not know which was the grown-up, how could you find out?

    (This question is accompanied by a picture of a caterpillar, a cocoon and a butterfly)

In the May, 1968, pilot study, the test was administered individually by the researcher to sixty third grade children. Their response to the questions were tape recorded. Later, forty of these children took the test in written form. The questions were read aloud to minimize the possible consequences of different reading abilities. The means and standard deviations for the written and taped test scores were very similar and correlated .87 to .90. The test-retest reliability was, therefore, at these values. A comparison of interview and written tests can be made from the data in Table I.

Table I

Means and Standard Deviations

for Written and Interview Scores in Pilot Study

Social-Economic Group	Means		Standard Deviations	
	Interview	Written	Interview	Written
Low--School A	4.10	3.90	1.72	1.52
Low--School B	3.40	3.30	1.17	1.16
Middle--School A	7.80	7.70	1.87	2.11
High--School A	8.40	8.50	1.66	2.17

Test Validity and Reliability

Test validity has many meanings. Ebel[12] suggests that an important consideration in test validity is the purpose for which the test is used and the group with which it is used. The test in this study was designed to determine if there were differences between children's understanding of selected science concepts and the methods of verification when social-economic groups were considered. The questions used for the purpose of determining the understanding of the children were based on the concepts included in the science textbook which was used by all groups. The children were asked what they could do to find out answers to the questions asked. This basis for question design and selection was believed to satisfy Ebel's definition of validity.

An individual test item should be answered correctly more often by students achieving a higher overall score than by students with

a low overall score. It should discriminate between the groups compared. A chi-square test of independence on the interview data in the Pilot Study showed significant differences, at the .05 level, between the three groups for 11 of the 15 test items. The high social-economic group answered all items correctly more often than the low group.

A test of internal consistency was also used on the interview data. Using Hoyt's formula[13] an internal consistency of .76 was obtained.

The results obtained in the pilot study were believed to justify using the written form of the test for the main study. In the fall of 1968, the written test was administered by the teachers in the same manner as the pilot study written form, providing data from 310 fourth grade students in fifteen classes in nine schools

Main Study Results

The five null hypotheses considered in the main study were concerned with differences between the three social-economic groups in I.Q. mean scores, raw scores on the test of scientific understanding, the means of the raw scores on the test of scientific understanding when the means were adjusted for I.Q. differences, the methods used to find out answers to questions and an item analysis for the science test.

Hypothesis One. The I.Q. scores were obtained for each child in the main study from the school district participating in the study. The Lorge-Thorndike Intelligence test had been given to the students one month before the science test. A one-way

analysis of variance was used to test the null hypothesis of no significant difference between the mean I.Q. scores of the three groups. The null hypothesis was rejected at the .01 level. The Student-Newman-Keuls test established that each group mean was significantly different from each other group mean. A summary is shown in Table II.

Table II

Analysis of I.Q. Test Scores by Social-Economic Level

Social-Economic Group I.Q.

	High	Middle	Low
No. Students	78	97	135
Mean	116.13	107.41	99.72
Stand. Dev.	11.39	13.04	11.80

One-Way Analysis of Variance

$F_{99}(2,200) = 4.71$ F value = 45.97 Reject Hypothesis

Student-Newman-Kuels

Significant Difference Between Means by Levels

Levels	High	Middle	Low
High		**	**
Middle			**
Low			

Hypothesis Two. The second hypothesis to be tested was that there was no difference in the mean level of scientific understanding of children from the three groups. A one-way analysis of variance test on the raw scores of the three groups and the Student-Newman-Keuls test to determine the significance of the difference between means was conducted. The null hypothesis was rejected at the .01 level and each mean was found to be significantly different from each other group mean. Table III summarizes these results.

Table III

Analysis of Mean Score on Science Test by Levels

Social-Economic Group Means

	High	Middle	Low
No. Students	78	97	135
Mean	7.04	6.14	2.71
Stand. Dev.	1.94	1.75	1.72

One-Way Analysis of Variance

F_{99} (2,200) =4.71 F value=179.83 Reject Hypothesis

Student-Newman-Keuls

Significant Differenc Between Means by Levels

Level	High	Middle	Low
High		**	**
Middle			**
Low			

Hypothesis Three. An analysis of covariance was used to test the third null hypothesis. When raw score means on the test for scientific understanding were adjusted for I.Q. differences, the null hypothesis of no difference in the mean level of scientific understanding of the children for the three groups was rejected at the .01 level. The Student-Newman-Keuls test showed that the low social-economic group mean was significantly lower than either the middle or high group mean but that there was no significant difference between the middle and high group means. A summary is shown in Table IV.

Table IV

Raw Test Scores Adjusted for I.Q. Differences

Social-Economic Group	High	Middle	Low
Adjusted Mean	6.29	6.06	3.21

Grand Mean = 4.87 Test Score

Covariance Analysis

F_{99} (2,200)=4.71 F Value = 114.61 Reject Hypothesis

Student-Newman-Keuls

Significant Difference Between Means by Levels

Level	High	Middle	Low
High			**
Middle			**

Hypothesis Four. The fourth hypothesis to be tested was there is no difference in the ways the students of the three social-economic groups would use to verify or obtain answers to questions about their scientific understandings. Since all answers were considered correct, no test of statistical significance could be used. The per cent of answers given in each category is found in Table V. Although the children in the low and high groups used books as a source of information about 14 per cent of the time, their actual answers were much different. In the low group, "dictionary" was usually specified while the high social-economic group often indicated a "science book about weather," or "a book about space" or some more specific source.

Table V

Methods Children Stated to Verify or Find Out Answers to Questions of Scientific Understanding

	Social-Economic Group		
Method	High	Middle	Low
Ask Parent	2.13	1.38	2.66
Ask Teacher	.52	.06	.29
Ask Other	3.84	3.16	4.35
Book-Newspaper	14.28	5.22	13.98
Radio-TV	.94	.97	.69
Observe-Experiment	74.87	78.90	56.74
No Answer	3.42	10.31	21.29

Numbers indicate % of times stated

Hypothesis Five. The fifth hypothesis of no difference in the number of correct answers given by the three groups to the individual items on the test of scientific understanding was rejected for 13 of the 15 items at the .05 level. The chi-square test of independence was used. The two questions falling below the chi-square value were, however, answered correctly more often by the children in the high and middle groups.

Summary of
Questions and Results

Question	Tested by	Results
1. Is there a significant difference between the mean I.Q.'s of the three social-economic groups?	One-way analysis of variance Newman-Keuls Test	Significant difference at .01 level between each group. X=High 116.13 Middle 107.41 Low 99.72 See Table II
2. Is there a significant difference between the mean scores on the test of scientific understanding when only raw scores are considered?	One-way analysis of variance Newman-Keuls Test	Significant difference at .01 level between each group. X=High 7.04 Middle 6.14 Low 2.71 See Table III
3. Is there a significant difference between the mean scores on the test of scientific understanding when the raw scores are adjusted for I.Q. differences?	Co-variance analysis Newman-Keuls Test	Significant difference at .01 level between low and high, 3.03-6.29; low and middle, 3.03-6.05. See Table IV

Question	Tested by	Results
4. Are there differences in the kinds of answers suggested by the three groups to the questions "How could you find out?"	Differences by percent	Major differences in Experiment-Observation. Selected least by low group. Low often no answers suggested. See Table V
5. Are there differences in the number of correct responses given by the three groups to individual test items?	Chi-square analysis	Significant at .05 level for 13 of 15 items. Low had least correct on each of the fifteen.

Conclusions

If differences in levels of understanding are influenced by social-economic factors, it would seem necessary, to this writer, to consider this when planning a curriculum for elementary science education. Metropolitan school districts using the same curriculum materials in all schools in a city that has a neighborhood school system, as well as many groups planning new elementary science curriculum materials, are in most cases ignoring the influence of social-economic factors on children's understanding.

If science education is to be concerned with the process of science,

experiment and observation, as well as the concepts of science, then some changes may be necessary in the curriculum. In the science test used in this study, the answers to all of the questions could have been determined by observation or experimentation. This method of finding out answers was suggested 56 percent of the time by the children in the low social-economic group compared to about 75 percent for the middle and high groups. A curriculum planned for children in the low social-economic group may need to include many opportunities for solving problems by observation and experimentation if development of this ability is accepted as an objective of science education.

In the pilot study of this research, the children were given a test of scientific understanding first by an interview method and two weeks later by written means. The test questions were read to the students taking the written form of the test so that wrong answers or failure to answer would be due to inadequacy of science background or knowledge rather than reading problems. There was very close agreement between the means and standard deviations for the interview and written tests and a high correlation of .87 to .90 between raw scores on the written and interview tests. It is possible that this method could be used in other research studies where the investigator wanted to test a large group of students but was concerned with the disadvantage some children would have on a written test because of their poor reading ability. The written test might be substituted satisfactorily for the interview method if the written test was read to the students.

This method of interview test and written retest may also provide one means of establishing reliability when the standard test-retest method is not desirable.

Children in all of the groups had the least correct answers to questions about the motion of the sun or on the influence of heat on the contraction and expansion of materials. The questions concerned with living things were answered correctly more often by the children in all of the groups. The metamorphosis of a butterfly was much more frequently understood by children than the motion of the earth around the sun, but if these concepts are included in the curriculum, as they were in this study, then better ways must be devised to help the children develop concepts of more abstract phenomena.

Synopsis

A test constructed to determine selected science concepts of children and the means they suggest to find out the answers to these questions was given to children in three social-economic levels. In the pilot study the results of the interview and re-test written methods were thought to justify using the written form of the test in the main study involving 310 fourth grade children.

Significant differences at the .01 level were found between the means of all three groups in the I.Q. test and raw test scores on the test of scientific understanding; between the low and middle and low and high social-economic groups when raw test score means were adjusted for I.Q. differences.

If differences in levels of understanding science are associated with social-economic factors, using the same text and materials may not be an effective teaching method. More opportunities for experiment and observation are needed.

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